

NEET CRASH COURSE

STRUCTURAL ORGANIZATION IN ANIMALS



↳ Animal tissue



↳ Locations

↳ Cockroach = Repro. =
⇒ Segments

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STRUCTURAL ORGANIZATION IN ANIMALS

⇒ **TISSUE**: a tissue may be defined as a group of one or more types of cells which are physically linked and has similar origin and specialized function(s) along with intracellular fluid.

□ The microscopic study of tissues is called histology.

✓ □ Father of histology = Paul Mayer

✓ □ Tissue term was given by Bichat.



⇒ **EXTRACELLULAR FLUID**: Most animal cells have narrow spaces around them and the fluid between them or around them is called extracellular or intracellular fluid. It plays a vital role in the movement of various substances across the cells.

⇒ **TYPES OF TISSUES**: 1. Epithelial tissue 2. Muscular tissue 3. Connective tissue 4. Nervous tissue

STRUCTURAL ORGANIZATION IN ANIMALS

↓ [EPITHELIAL TISSUE → Avascular

→ The word epithelium was given by

= Fredrick and Ruysch.

Origin: by all three germ layers.

-epidermis: by ectoderm

-coelomic cavities: mesoderm

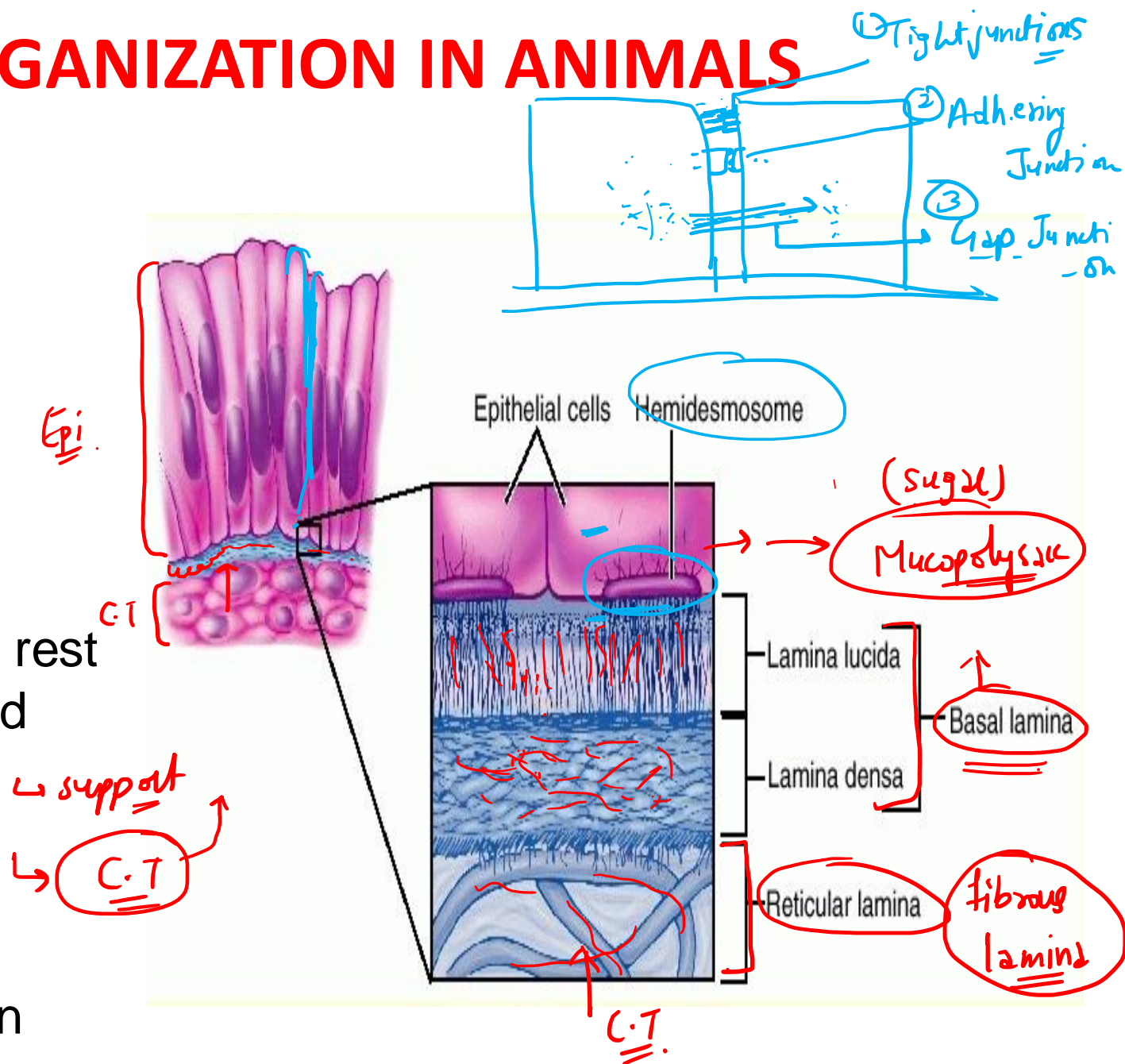
-epithelial linings: endoderm

= **BASEMENT MEMBRANE**: epithelia rest on thin, non-cellular membrane called basement membrane.

It is bilayered.

□ Outer layer: basal lamina (thin; in contact with epithelia)

□ Inner layer: fibrous lamina (thick; in contact with connective tissue)



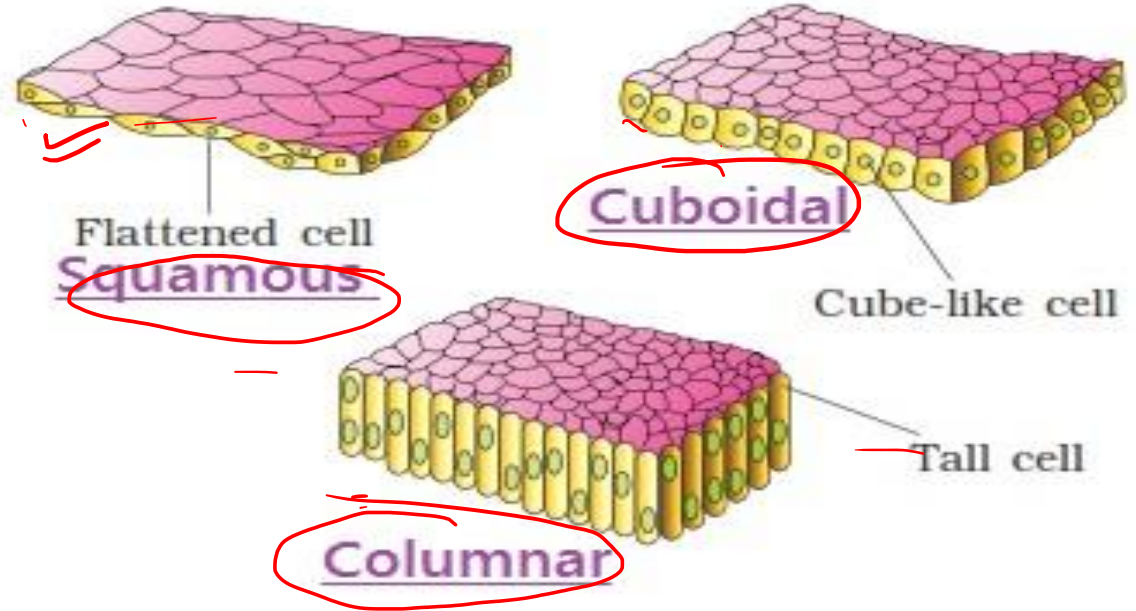
STRUCTURAL ORGANIZATION IN ANIMALS

CLASSIFICATION:

1. Simple epithelial tissue - *Shape*

- a. Squamous ✓
- b. Cuboidal ✓
- c. Columnar ✓
- d. Ciliated] ✓
- e. Pseudostratified]

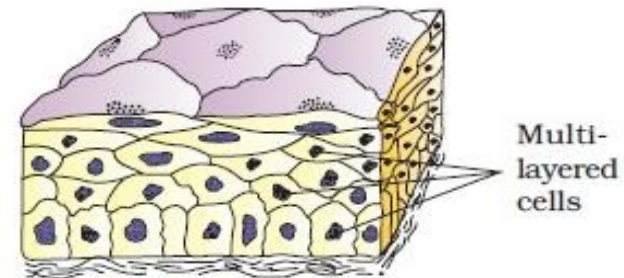
Single



2. Compound epithelial tissue → *Multi-layered*

- a. Stratified i. Keratinized ii. Non-keratinized

- b. Transitional epithelium → *has stretchability*



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SIMPLE EPITHELIAL TISSUE

→ ① SQUAMOUS

Structure: thin, flat, disc-like cells fitted tightly like the tiles of floor; hence also called pavement epithelium.

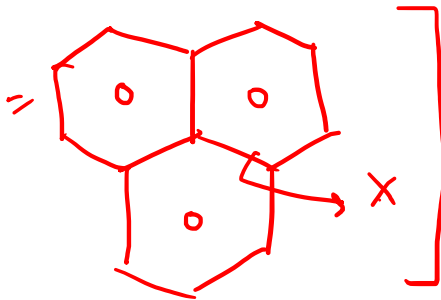
-They are roughly polygonal in surface view.

-Nucleus is flattened and is present at the center of the cells.

Location: inner cheek linings, Bowman's capsule linings; alveoli linings; blood vessels etc.

Squamous

Function: protection; secretion; exchange of gases, excretion etc.



Pavement
epithelium

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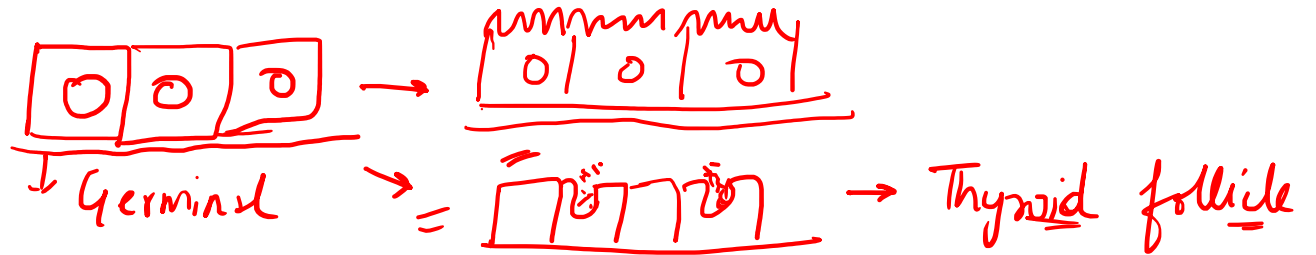
CUBOIDAL EPITHELIA:

Structure: cells are tall as well as wide.

Nucleus is round and at center.

lingual pancreas

Nephron



Location: ducts of glands; at PCT (here they have microvilli) **In nephron (at PCT) it is also called "Brush bordered cuboidal epithelium" (because of presence of microvilli) and; it is also present in ovaries and testes (at sperm producing tubules), here it is called "Germinal epithelium".

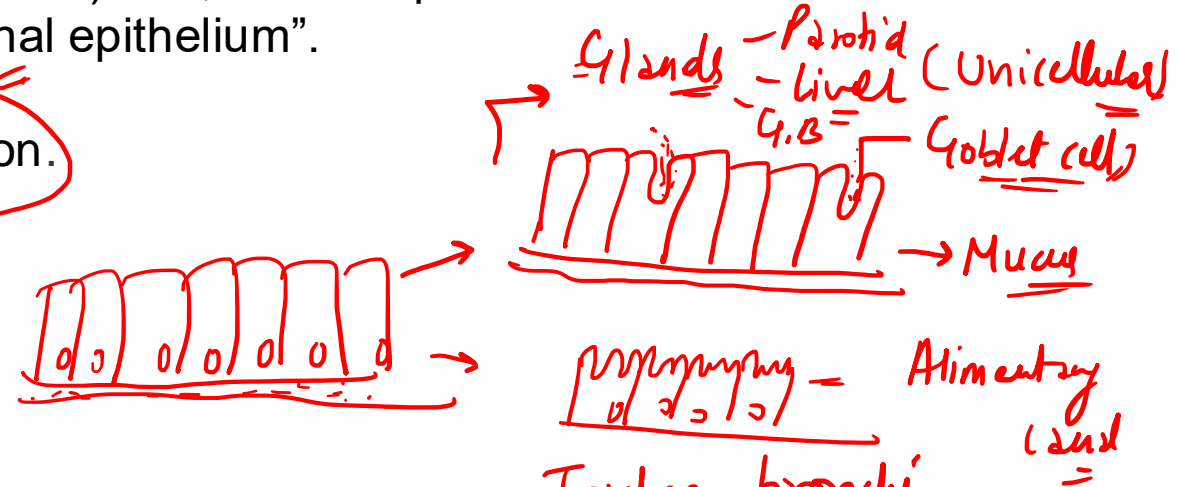
Function: protection; secretion; absorption; gamete formation.

COLUMNAR EPITHELIA:

Structure: cells are much taller than wide.

Nucleus is elongated and is present at variable positions.

Location: stomach; pancreatic tubules; gastric gland; intestine; gall bladder linings. , *Trachea, bronchi*



Function: protection; secretion; absorption. At stomach and intestinal linings, this tissue secretes a slimy fluid (i.e. mucus) and such cells are called Goblet cells. In intestine, this tissue bears microvilli at free ends.

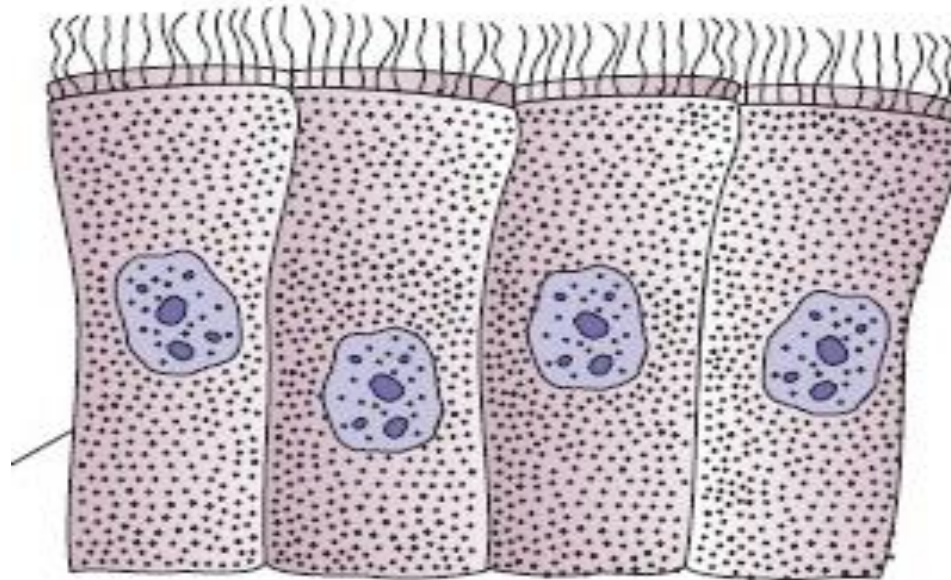
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CILIATED EPITHELIA:

Structure: the cells bear fine, motile, cytoplasmic processes called cilia. They arise from basal granules present below cell membrane. Ciliated epithelia Cuboidal ciliated Columnar ciliated

Location: urinary bladder nasal passage, oviduct, spinal cord of embryo, bronchiales
↳ columnar ↳ Columnar

Function: protection and movement of substances in a particular direction because they have whip-like structures called cilia.



(d)

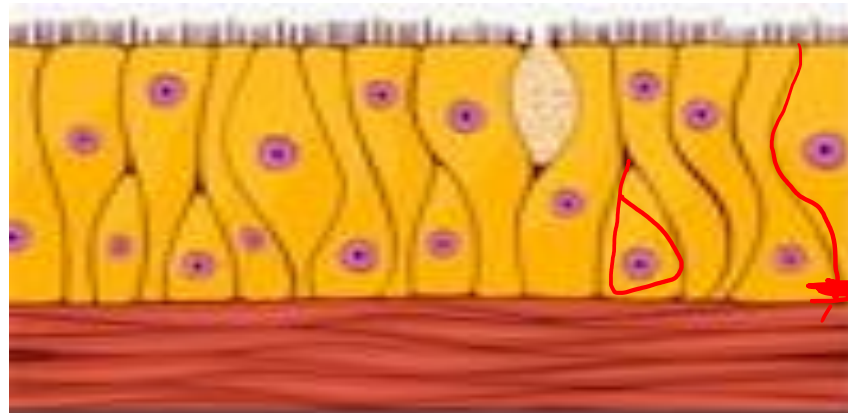
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PSEUDOSTRATIFIED EPITHELIA:

Structure: they are one-layered thick but appear two-layered because of some short cells which do not reach to the free surface. But all the cells touch basement membrane.

Location: (lines large ducts) trachea, large bronchi etc. parotid salivary duct, Urethra of males, Olfactory mucosa etc.

Function: protection; movement of secretions from glands, urine and semen in urethra and mucus loaded with dust and bacteria in trachea towards larynx.



→ single layer.

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COMPOUND EPITHELIAL TISSUE:

- Compound epithelial tissue consists of a few to several layers of cells. They are thicker and stronger than simple ones.
- Their deepest layer rest on basement membrane and is called Germinative Layer or Stratum germinativum.
- All the layers between germinative layer and the outer layer or free end are called Transitional Layers or Intermediate Layers.

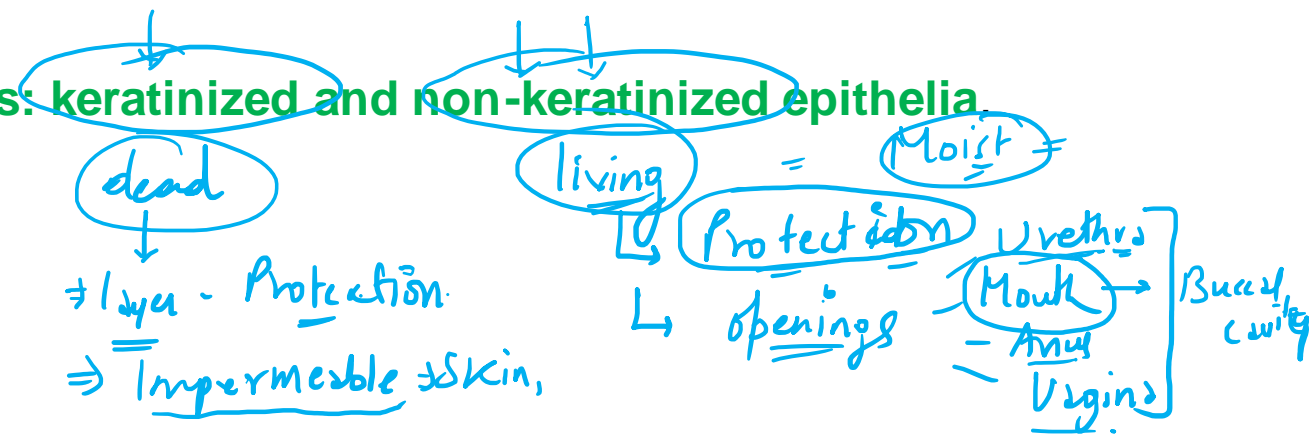
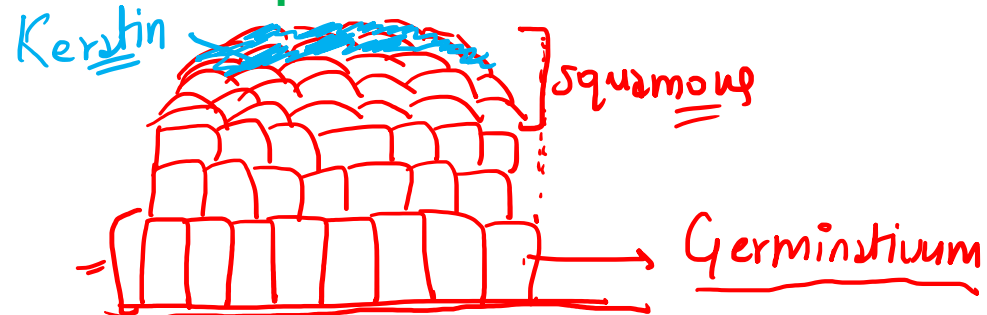
STRATIFIED EPITHELIA:

They have many layers of cells. ✓

Germinal cells are low columnar type and outer or surface layers vary in nature.

Based on the nature or shape of cells they are of four types: stratified squamous, cuboidal, columnar and ciliated.

Stratified squamous is sub divided into two parts: keratinized and non-keratinized epithelia



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i. Keratinized stratified squamous epithelial tissue:

In this, outer few layers replace their cytoplasm with hard, waterproof protein called keratin (or horn).

It form an outer layer called Horny Layer (Stratum corneum). → Snake-moulting →

This process of horny layer formation is called Keratinization.

Location: epidermis of skin

Function: prevent loss of water and provide mechanical support.

ii. Non-keratinized stratified squamous epithelial tissue:

In this tissue, keratinization does not occur. Hence there is no horny layer found at the surface.

Living cells are present at the surface.

Location: buccal cavity, oesophagus, anal canal, vagina and lower part of urethra.

Function: protection against abrasion of food.

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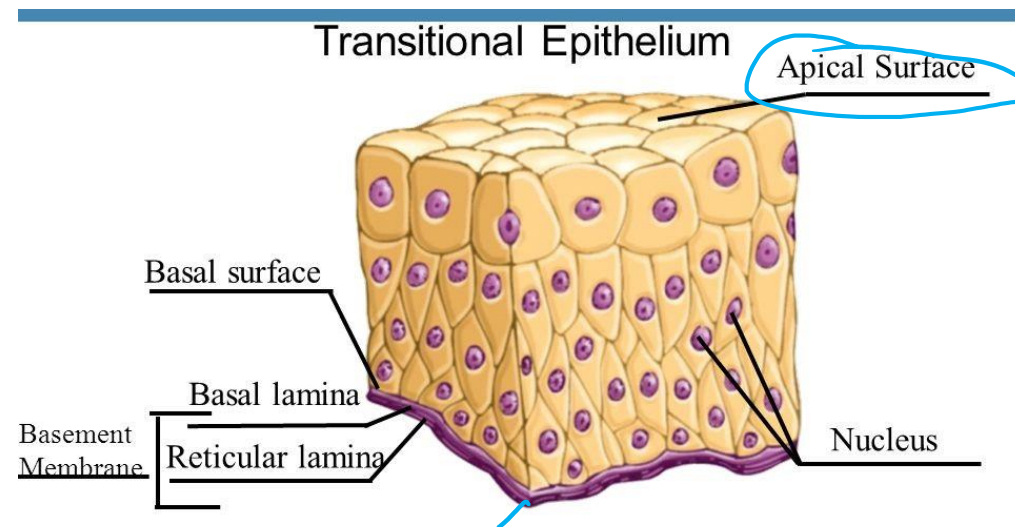
TRANSITIONAL EPITHELIA: (Urothelium)

They differ by stratified epithelia in having fewer layers (3 or 4) of cells, less flattened surface cells and remarkable flexibility.

Surface cells: globular (globe shaped) Intermediate cells: polyhedral Lower (germinal) cells: columnar o

Location: lines the organs which undergo considerable expansions. (Urinary bladder, Ureter)

Function: their cells stretch when expansion occurs and during contraction, they acquire their original position i.e. they start folding.



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CLASSIFICATION OF EPITHELIAL TISSUE BASED ON FUNCTIONING

GLANDULAR EPITHELIA: It has columnar type cells.

They produce useful materials from them.

They are specialized for secretions.

They may be unicellular (goblet cells; single isolated cell) or **multicellular** (many cells play in a single unit like a cluster; salivary gland and sebaceous gland).

oil

Cell Junctions

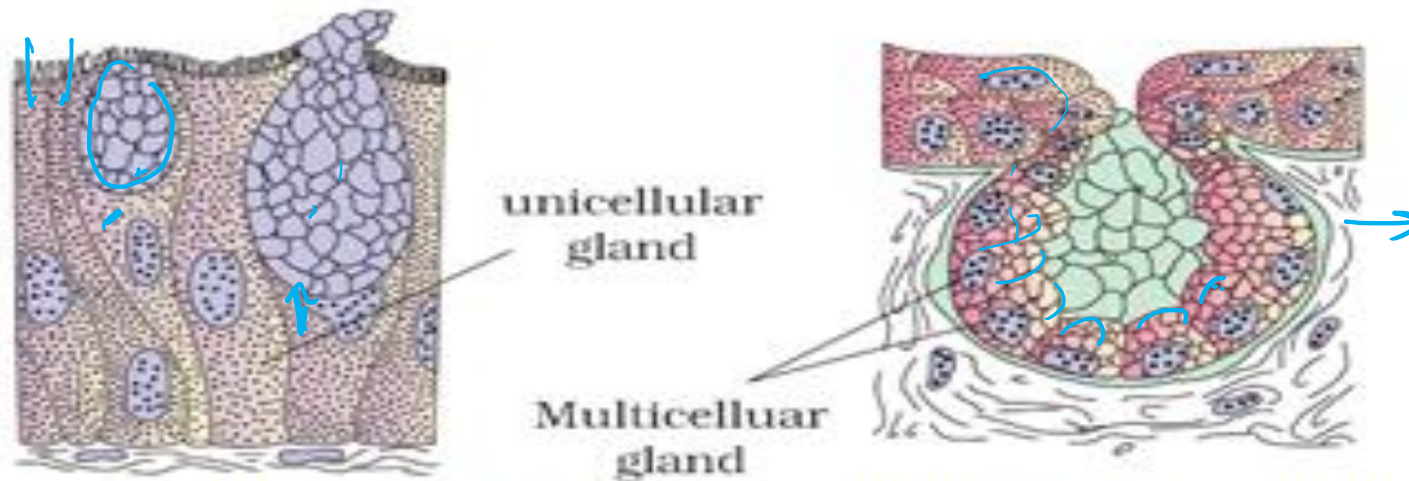


Fig.: Glandular epithelium : (a) Unicellular (b) Multicellular

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↓
MUSCULAR TISSUE (40% mammal's body weight)

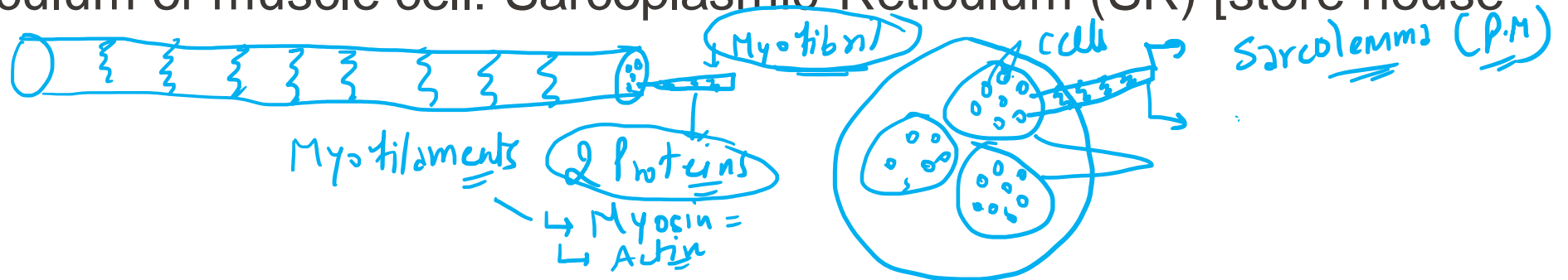
Origin: mesoderm

Special properties: 1. **Contractility:** property of shortening and expanding.
2. **Electrical excitability:** energy stored in electrical potential difference across the plasma membrane.

General Structure: Muscle tissues consist of long narrow cells called muscle fibers. These muscle fibers are made up of parallel arranged proteins called myofibrils.

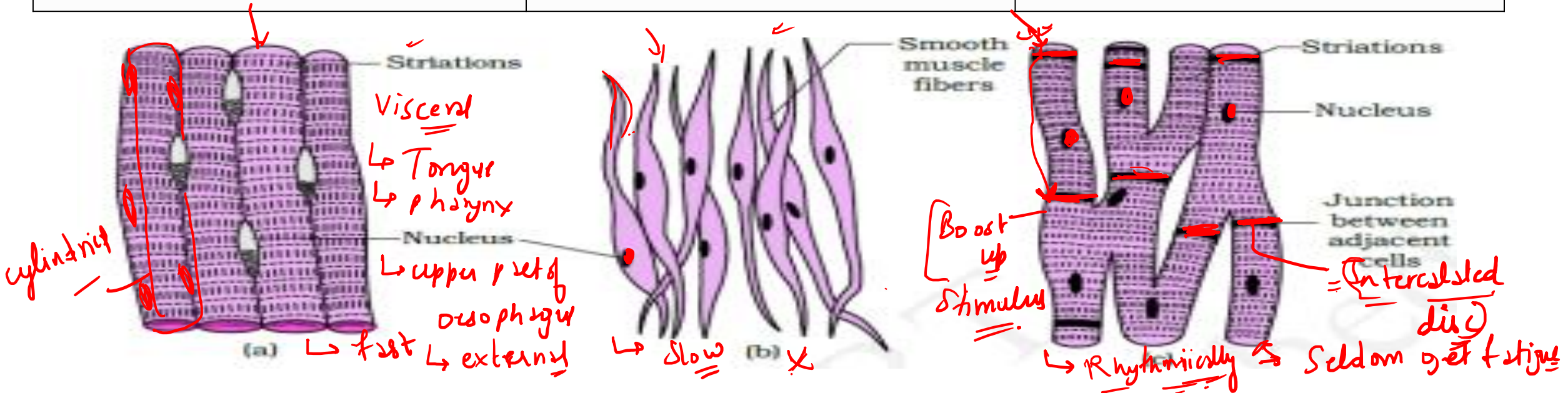
Cell membrane of muscle cells: Sarcolemma

Endoplasmic reticulum of muscle cell: Sarcoplasmic Reticulum (SR) [store house of Ca^{2+} ions]



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Skeletal / striated / voluntary	Smooth / <u>Visceral</u> / involuntary	Cardiac / <u>Involuntary</u>
<ol style="list-style-type: none"> 1. They are also known as striated, voluntary muscles. 2. Multinucleated with light and dark bands. 3. They are attached with <u>bones</u>. 4. They are fibrous and un-branched, cylindrical in shape. 	<ol style="list-style-type: none"> 1. They are known as unstriated or involuntary muscles. 2. They are uninucleate without bands. 3. They are present in vessels, oesophagus. 4. They are fibrous and un-branched, spindle shaped. 	<ol style="list-style-type: none"> 1. They are known as heart muscles and involuntary in nature. 2. Uninucleate with faint light and dark bands. 3. They are present in wall of <u>heart</u>. 4. They are fibrous and branched, cylindrical in shape.



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CONNECTIVE TISSUE They are named so because they have a special property or function of linking and supporting other tissues or organs of the body.

They are the most abundant type of animal tissue

Origin: mesoderm.

General Structure: They consist of variously shaped cells lying wide part in a large amount of non-living intercellular material called matrix.

Matrix is generally consist of protein fibers (polysaccharides).

Thus connective tissue comprises of two parts: cells and matrix.

- Mucopolysaccharides
- Glycoproteins

Tissue is divided as follows:

1. Loose connective tissue \rightarrow Matrix \uparrow
2. Dense connective tissue \rightarrow Matrix \downarrow
3. Specialized connective tissue \rightarrow Skeletal \rightarrow Matrix - Negligible
Fluid - Fibres - No

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LOOSE CONNECTIVE TISSUE

1. AREOLAR TISSUE:

Location: it is distributed in almost all over the animal body.

Function: they connect one tissue or organ with others and also forms packaging nearly in all the organs.

Structure: It consist of transparent, jelly-like, sticky matrix that contains many cells and fibres.

Fibers: a. White fibre-Formed by collagen protein → *Rigidity*

b. Yellow fibre-Formed of elastic protein → Elasticity

c. Reticular fibres → Reticulin - Rigidity

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2.ADIPOSE TISSUE:

Structure: many fat cells (adipocytes) are present with large fat globules. *Heredity, exercise and the amount of fat we eat can all affect the amount fat our adipose tissue stores.

Location: Around heart, kidney and blood vessels etc. Blubber of whales, humps of camel and fat bodies of frogs.

Function: They reserves food.

Prevent heat loss.

Act as shock absorbing cushions.

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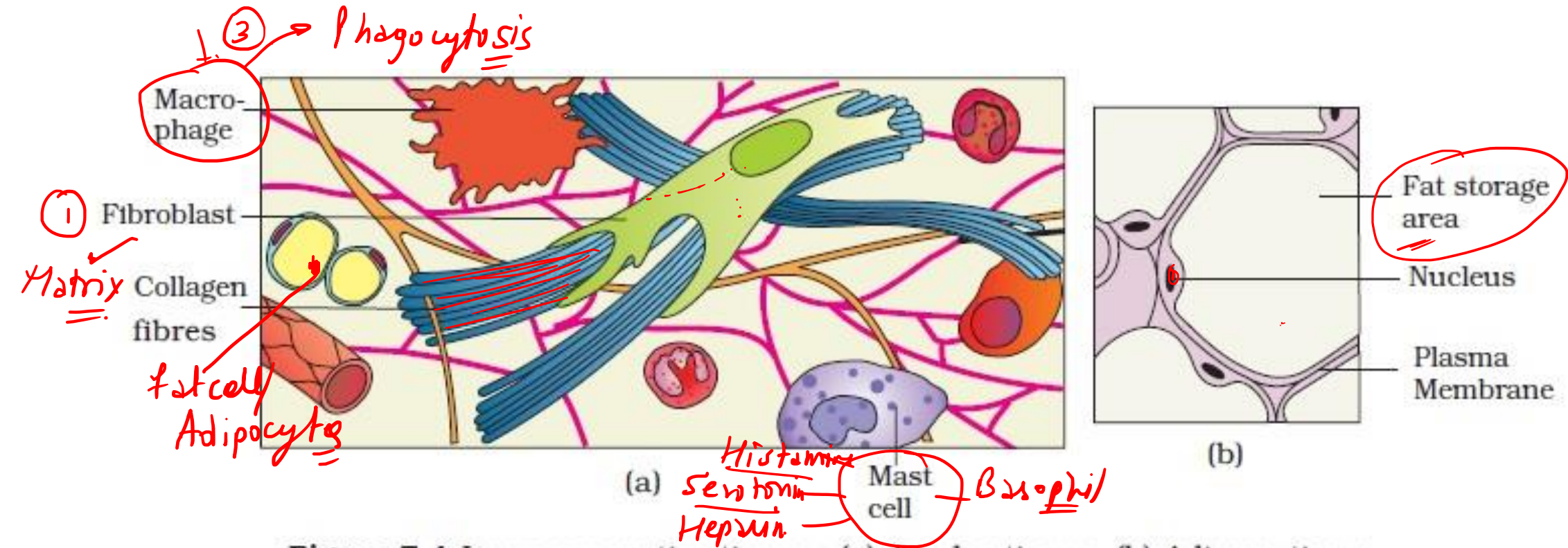


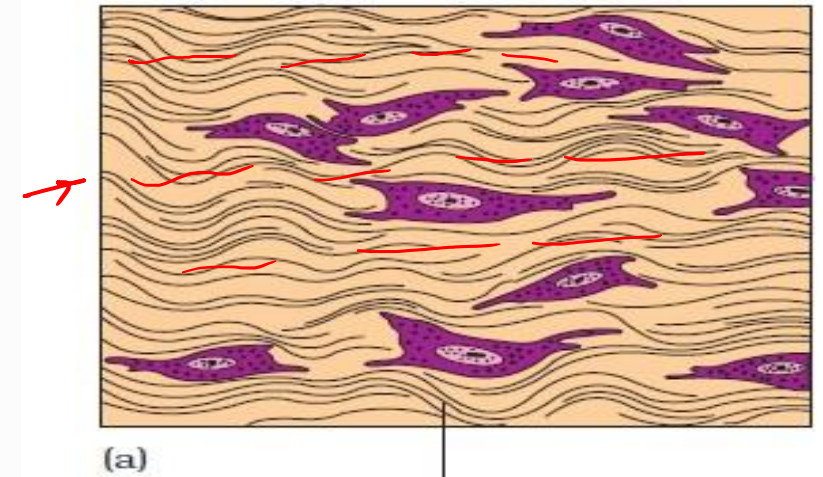
Figure 7.4 Loose connective tissue : (a) Areolar tissue (b) Adipose tissue

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↓
Dense connective Tissue contains fibres and fibroblast compactly packed. The orientation of fibres may be regular or irregular pattern.

- In dense regular connective tissues collagen fibres are present in rows between parallel bundles of fibres as in tendons and ligaments.

Tendon	Ligament
<p>1. Tendon connects bones to skeletal muscles.</p> <p>2. It is made up of white fibrous tough tissue.</p> <p><i>Collagen</i></p>	<p>1. Ligament connects one bone to another bone.</p> <p>2. It is made up of yellow elastic tissue with collagen fibres.</p>



(a) Collagen fibre

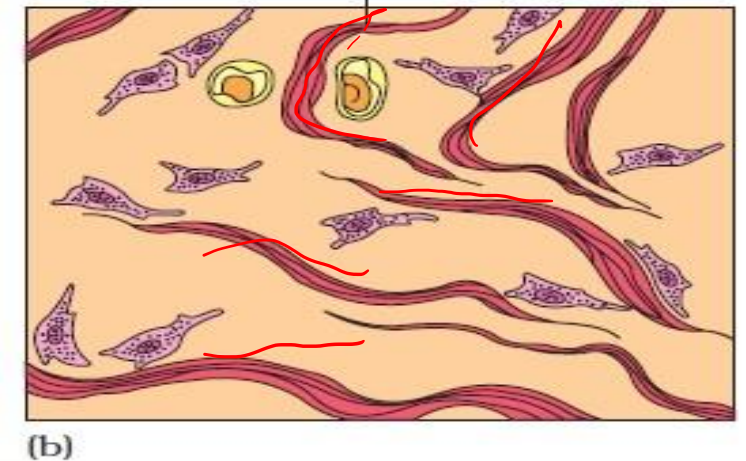


Figure 7.5 Dense connective tissue:
(a) Dense regular
(b) Dense irregular - skin

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1. **CARTILAGE:** They are solid and semi-rigid.

Structure:

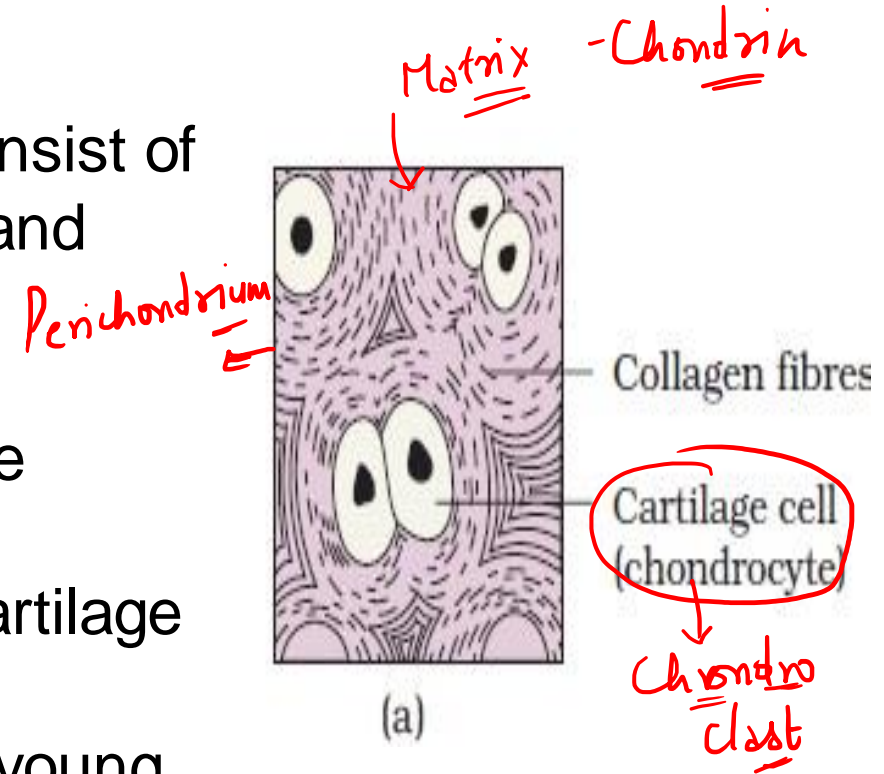
1. **Matrix:** It is rubbery; made up of chondrin sulphate; consist of proteoglycan. Matrix is also composed of cartilage cells and fibers (mainly collagen).

2. **Chondroblasts:** (cells of cartilage) -Oval in shape, large nuclei
↳ Chondrocyte →

-Chondroblasts lie in a fluid space in the matrix called cartilage lacuna.

- Chondroblasts near perichondrium are small, oval and young and are called chondrocytes. Injury to cartilage takes more time to heal because of lack of blood supply - Avascular

3. **Perichondrium:** It is an outer stiff sheath that bounds the cartilage



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TYPES OF CARTILAGE:

1. **Hyaline Cartilage** → Matrix - Hyaluronic acid.



It is clear, homogenous, translucent and bluish-green.

Very fine collagen fibers; difficult to observe.

Flexible, elastic and compressible.

Location: bronchial rings, laryngeal walls, sternal ribs, tracheal rings etc. *long bones, Nasal Septum.*

2. **Fibrous cartilage** (white and yellow) → Matrix -

a. **White fibrous cartilage:** lack perichondrium. They are located between vertebral discs, pubic symphysis etc.  

b. **Yellow elastic cartilage:** it is most elastic cartilage. It is opaque and yellowish. Perichondrium is present. It is located in epiglottis, pinna, auditory canal of ear, nose tip etc. *Eustachian tube.*

↓
3. **Calcified cartilage**

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BONE: It is hardest tissue in the body; due to calcification of its matrix.

It constitutes skeleton, provide support and protection.

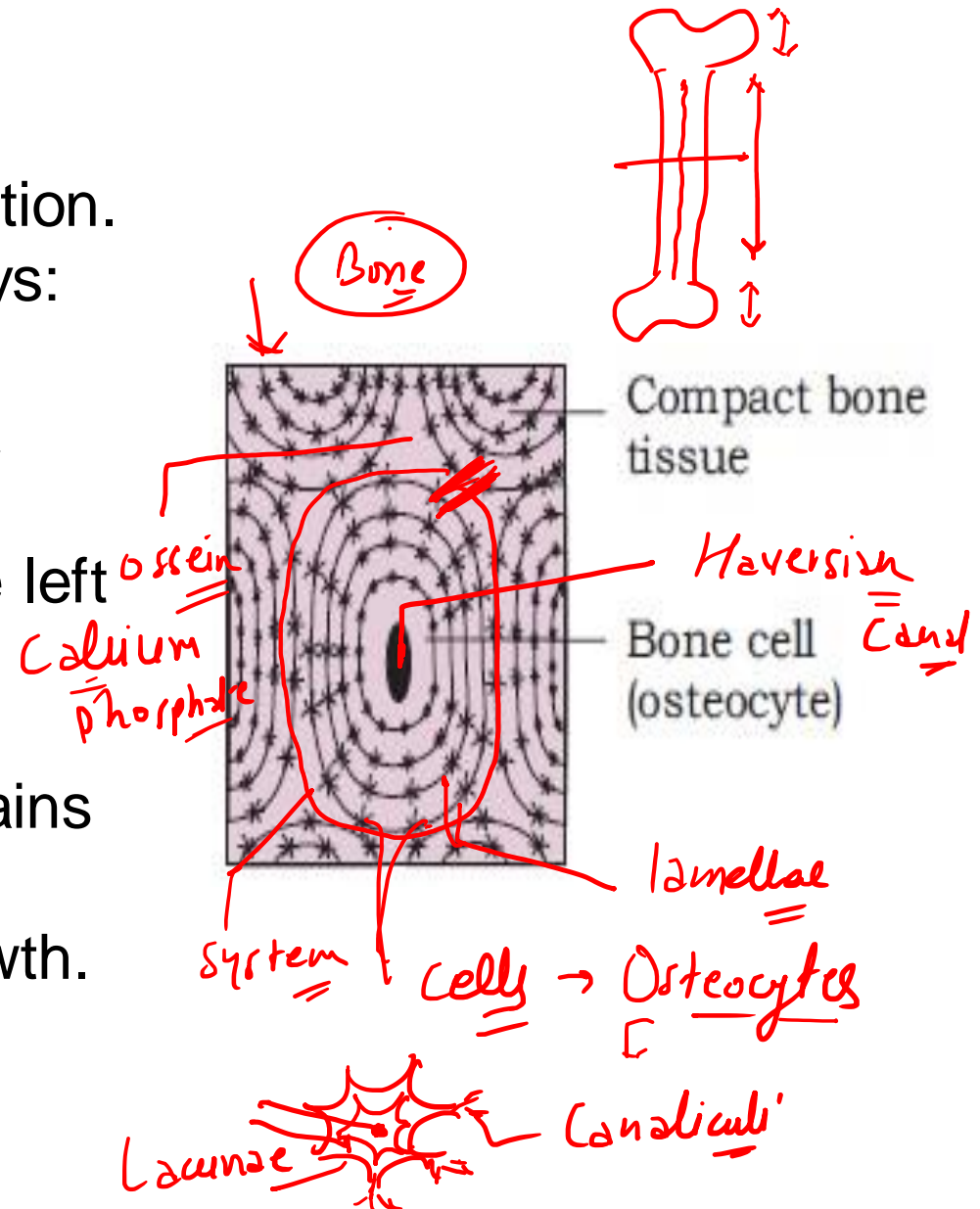
Its histology (osteology) can be studied in two ways:

a. If the bone is dried.

b. If the bone is decalcified (If the bone is kept in a dilute acid (5% HNO_3) for some time, then its inorganic part is dissolved and organic part will be left behind).

-Periosteum: it covers bone externally and it contains active bone cells, called osteoblasts. These cells produce new bone material which helps in its growth. Periosteum contains blood vessels.

Endosteum: it covers marrow cavity.



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Structure of Bone:

Matrix It is made up of protein called **Ossien**. It contain collagen fiber which provide it strength. Rather than these organic matters, bone matrix is also composed of inorganic matter like sulphates, phosphates, fluorides, and carbonates of calcium and magnesium. Among all the salts present in the bone, Calcium Phosphate has major proportion.

Lamellae: layers in the matrix which are arranged in concentric form around narrow longitudinal cavities called Haversian Cavities.

Circumferential Lamellae: lamellae around the marrow cavity and the whole bone.

Lacunae: small, fluid spaces in the lamellae. They contain inactive bone cells called Osteocytes. Lacuna give off some radiating channels which crosses lamellae called Canaliculi. They are small and thin.

Osteocyte: (inactive bone cells) It stores glycogen. In developing stage, osteocytes possess many protoplasmic processes called Filopodia which extend through canaliculi. As maturity comes, these filopodia get withdrawn.

-**Haversian system:** haversian canal, lamellae, lacunae and canaliculi together make haversian system. (also called osteon). The haversian canala are connected with transverse channles called Volkmann's Channel. They contain blood vessels (arteries and veins), lymph vessels and nerves.

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↳ FLUID CONNECTIVE TISSUE:

It has fluid matrix.

Its matrix lacks fibers and floats freely and flows in the body.

Vascular tissue is also called Fluid connective tissue.

CLASSIFICATION OF VASCULAR TISSUE:

1. ✓ Blood = Plasma + RBCs + WBCs + Platelets

2. ✓ Lymph = Plasma + WBCs

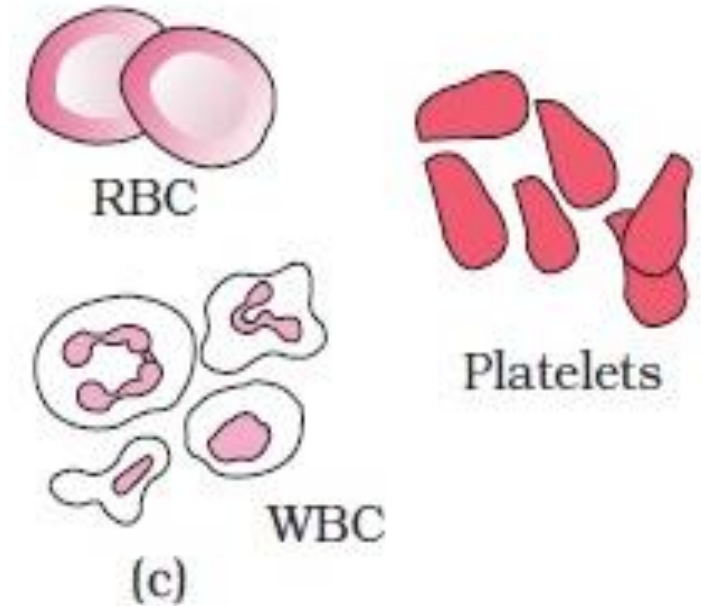
few proteins

BLOOD:

-6.8L in adult person on an average.

-6-10% body weight.

-Study: Hematology.



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PLASMA:

- It is faint yellow colored and slightly **alkaline**.
- Plasma without clotting factors is called **serum**.
- Composition: Water 90% Proteins 7-8% Inorganic salts 1% Others (food, gases, waste, anticoagulants, antibodies, cholesterol etc.) 1-2%
- Plasma proteins:**
 - Albumin** and **globulin** maintains osmotic pressure of plasma i.e. 7.6 atm.
 - Some globulins (eg. immunoglobulin) form **antibodies** in response to the injury of antigens.
 - Properdin destroys bacteria, viruses, foreign RBCs etc.
 - Prothrombin and **fibrinogen** are clotting factors.
- Inorganic salts:** These are- Na^+ , Ca^{++} , Mg^{++} , Cl^- , CO_3 , PO_4 etc. They are present in the form of ions. So, they are also called Blood (Plasma) Electrolytes.
- Food materials:** (glucose, amino acids, fatty acids etc.)
- Normal content:** 80-100 mg glucose/100 ml of blood (for 12 hrs. after meal).
- Waste:** urea, uric acid, ammonia.
- Gases:** oxygen, carbon dioxide, nitrogen (in dissolved form)
- Regulatory substances:** hormones, enzymes and proteins.
- Anticoagulants:** anti-prothrombin/ heparin.
- Cholesterol:** synthesized by liver and released in blood. Its normal range is 50-180 mg/ 100 ml of blood. If this range exceeds heart problems can be faced

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RED BLOOD CORPUSCLES (RBCs): (Erythrocytes)

- They are the most abundant cells in our body. ✓
- On an average about 2.5 million RBCs are formed in a second.
- They are red in color and contain a red colored pigment in them made up of iron called hemoglobin (Hb). Hb carries oxygen. =
- Shape: in mammals, RBCs are circular (front front) and biconcave (from side view) and are enucleated. Llama and camel has biconvex RBCs.
- Size: smaller than WBCs (diameter = $7-8\mu\text{m}$ and thickness = $2\mu\text{m}$)
- Number: 4.5-5.5 million RBCs/mm³ blood
 - Abnormal decrease in RBC count = Erythrocytopenia
 - Abnormal increase in RBC count = Polycythemia
- Formation: (Erythropoiesis) It occurs in liver and spleen in foetus and in red bone marrow after birth. Excess RBCs are stored in spleen. Vitamin B12, proteins, iron and folic acid stimulates erythropoiesis.
- Color: yellowish when a cell is seen singly and red when seen in bulk. Red color is due to hemoglobin.
- Hemoglobin: It is a red colored pigment present in blood. It consists of globin (protein) joined by heme (non-protein) hence named.

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WHITE BLOOD CORPUSCLES (WBCs): (Leucocytes)

- They lack hemoglobin and contain nucleus.
- Shape: Irregular
- Number: Total WBC count = 5000-10000 WBCs/mm³ of blood
Rise in WBC count = Leucocytosis
Fall in WBC count = Leucopenia
- Color: colorless
- Formation: (Leucopoiesis): occurs in lymph nodes, red bone marrow, thymus and spleen.
- Life span: 3-4 days

Types of WBCs:

1. Agranulocytes: granules are absent


- Monocytes**: largest WBC (10-20µm); phagocytic in nature; pale blue cytoplasm.
- Lymphocytes**: small in size (7-10µm); nucleus is round and large (20-40%); secrete antibodies; heals wounds.

2. Granulocytes: granules are present.

- Basophiles**: blue and black granules; contain histamine; s-shaped nucleus
- Eosinophils**: brick red granules; bi-lobed nucleus - Anti-Allergy.
- Neutrophils**: Fine red brown granules; multi-lobed nucleus → Phagocytosis

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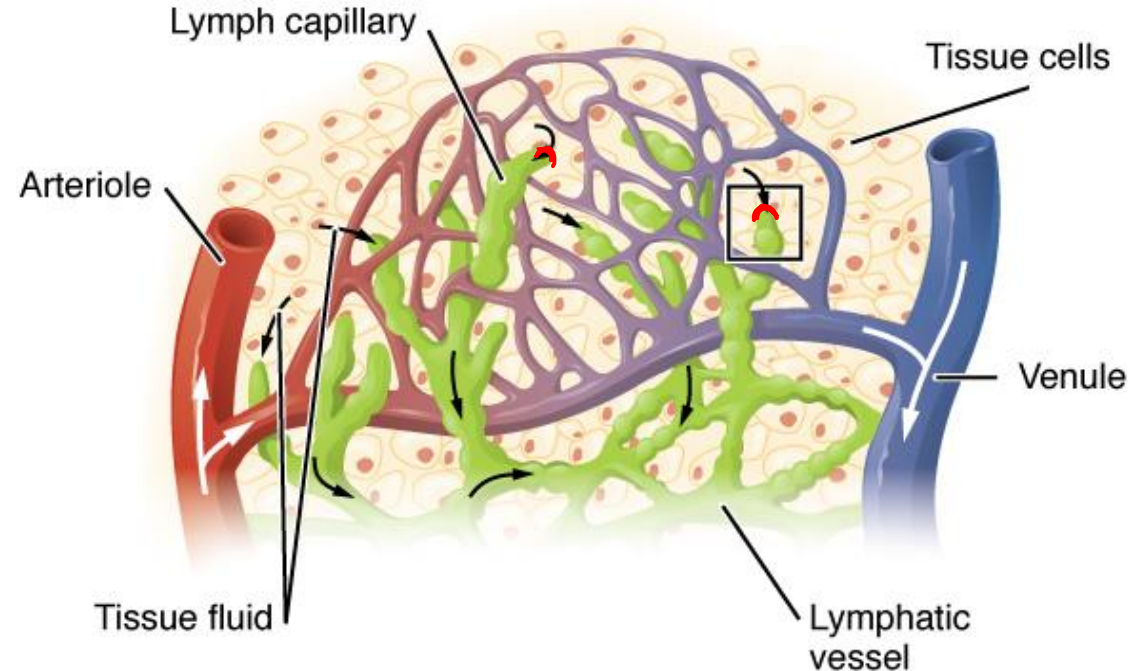
PLATELETS: (Thrombocytes) =

- Shape: spindle-shaped  enucleated
- Color: colorless
- Size: 2-5 μm wide only (smallest blood cells)
- Number: Platelet count = 250000 cells / mm³ blood
 - Rise in platelet count = Thrombocytosis \uparrow
 - Fall in platelet count = Thrombocytopenia \downarrow
- Formation: Thrombopoiesis (in red bone marrow)
- Life span: 3-7 days

STRUCTURAL ORGANIZATION IN ANIMALS

LYMPH:

- It is colorless. //
- Composed of plasma and WBCs only (mostly lymphocytes).
- It flows in lymphatic capillaries.
- Function: it carries materials from tissue into blood stream or vice versa.



STRUCTURAL ORGANIZATION IN ANIMALS

NERVOUS TISSUE

- Origin: ectoderm
- Nervous tissue forms nervous system.
- The functional and structural unit of nervous tissue is neuron or nerve cell.

NEURON:

- They do not divide after their maturity as they lack centrioles.
- It is the longest cell in our body.
- It has 3 parts:
 - 1.**Cell body**(cell soma or cyton)-Contain nucleus and certain granules called Nissl's granules. Cytoplasm is called Neuroplasm.
 2. **Dendrites**:These are short, tapering, much branched protoplasmic processes of cyton. They arise from a region at cyton called Dendron.They also contain Nissl's granules. They conduct impulse to cyton.
 3. **Axon**: it is longest protoplasmic process of the cyton.It conducts signals (impulse) from cyton to the next nerve cell's dendrite via axon terminals.

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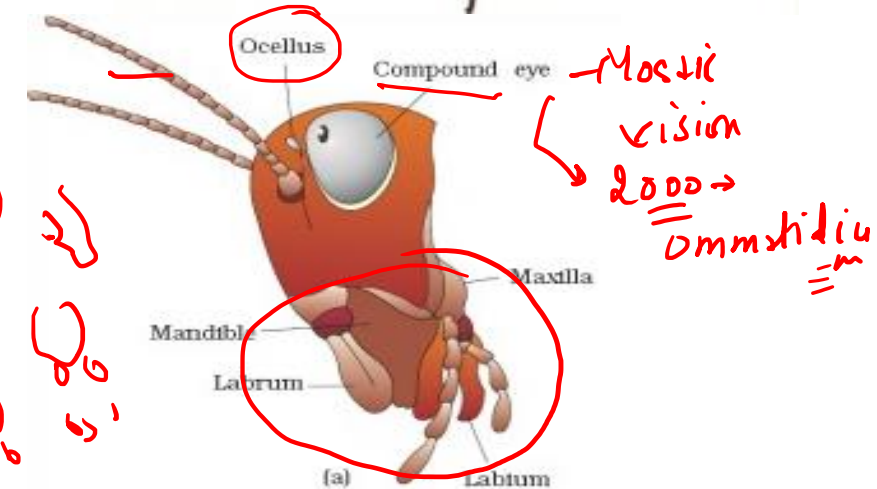
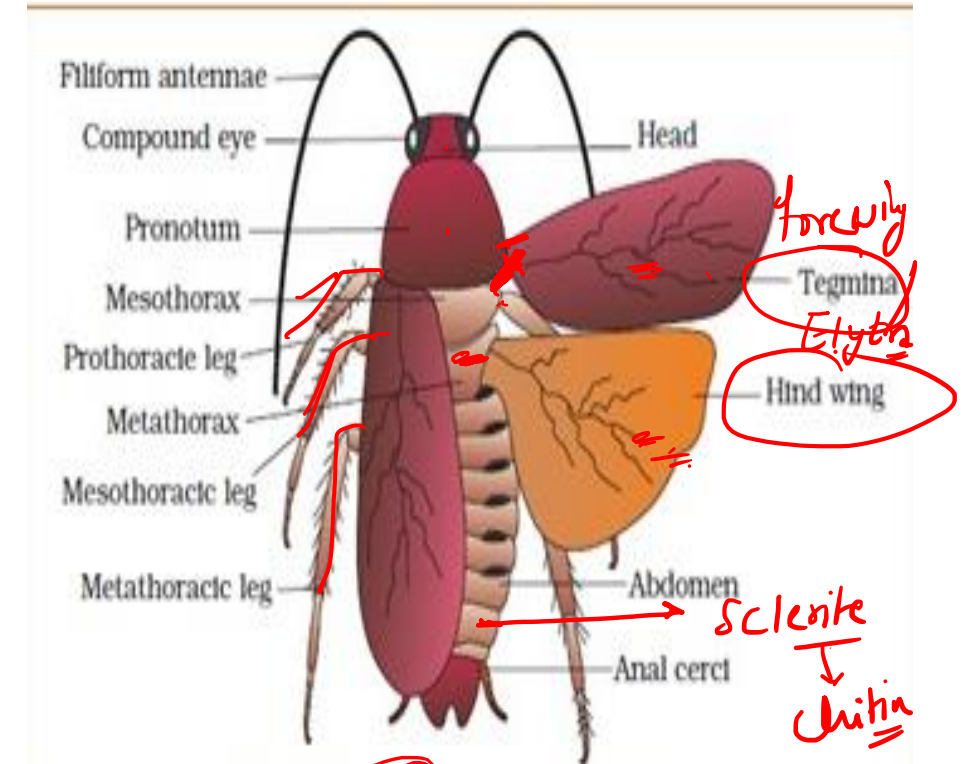
↳ Cockroach (*Periplaneta americana*)

- Cockroaches are nocturnal omnivorous organisms that live in damp places everywhere. The body of a cockroach is segmented and divisible into **head**, **thorax** and **abdomen**. The body is covered by a hard chitinous exoskeleton.

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- Head is triangular in shape, formed by the fusion of six segments to show flexibility. The head bears compound eyes. Antennae attached to the head help in monitoring the environment.

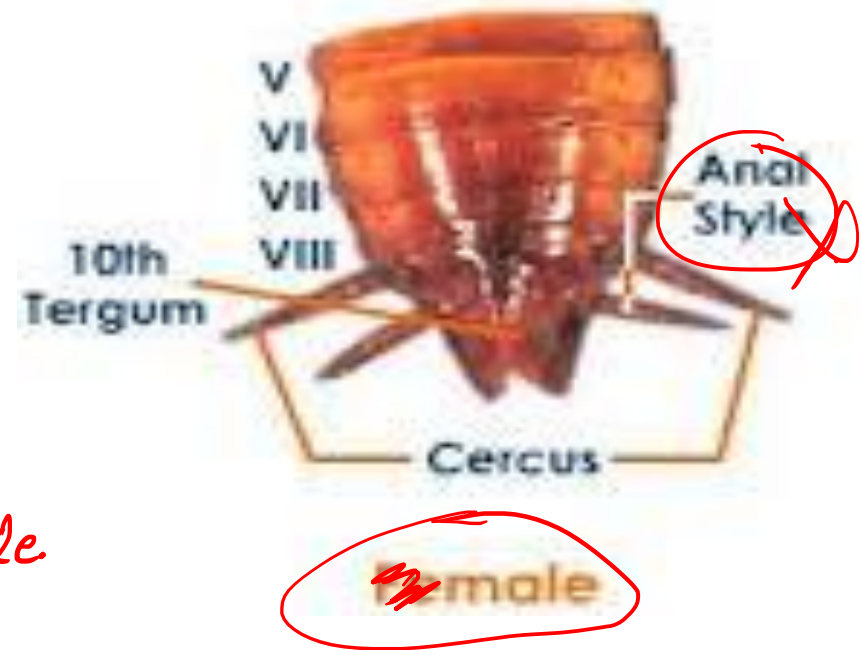
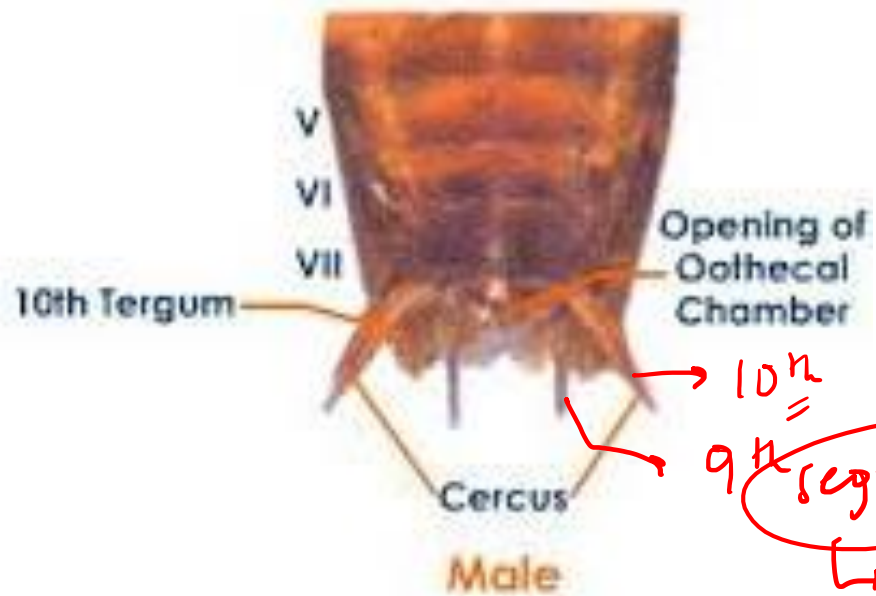
- Thorax consists of three parts- prothorax, mesothorax and metathorax. Forewings and hind wings are attached to the thorax. Abdomen consists of 10 segments.



Handwritten notes in Urdu script:

کڑکڑاہٹ (Khar-kharat) - Crackling sound
کڑکڑاہٹ (Khar-kharat) - Crackling sound
کڑکڑاہٹ (Khar-kharat) - Crackling sound
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STRUCTURAL ORGANIZATION IN ANIMALS



Male Cockroach	Female Cockroach
<ul style="list-style-type: none">1.The abdomen is long and narrow.2.Brood pouch is absent.3.Male have longer antenna.4.Anal styles are present.	<ul style="list-style-type: none">1.The abdomen is short and broad.2.Brood pouch is present.3.Female have shorter antennae.4.Anal styles are absent.

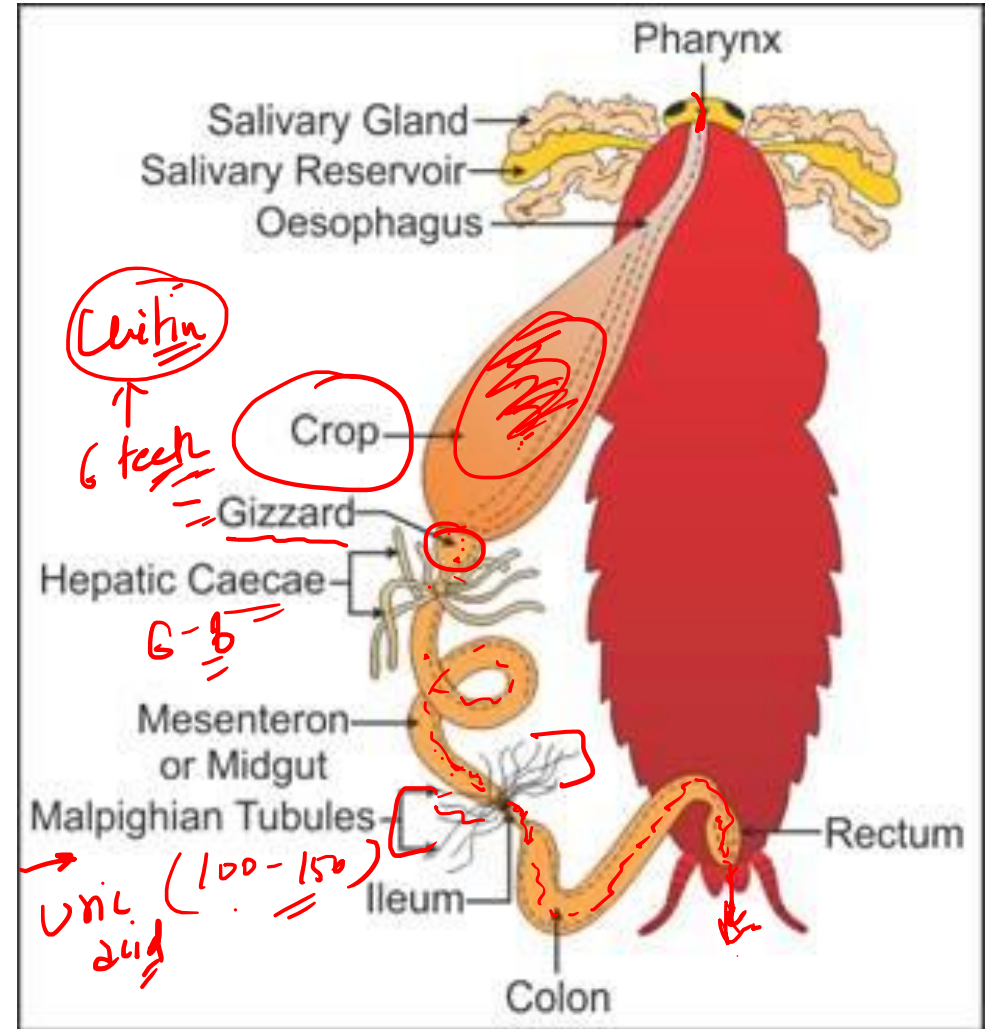
STRUCTURAL ORGANIZATION IN ANIMALS

Digestive System of Cockroach-

Alimentary canal is divided into foregut, midgut and hindgut. Food is stored in crop. Gizzard help in grinding the food particles.

- At the junction of midgut and hindgut yellow coloured filamentous **Malpighian tubules** are present which help in excretion.

Blood vascular system is open type having poorly developed blood vessels. The haemolymph is made of colourless plasma and haemocytes.



STRUCTURAL ORGANIZATION IN ANIMALS

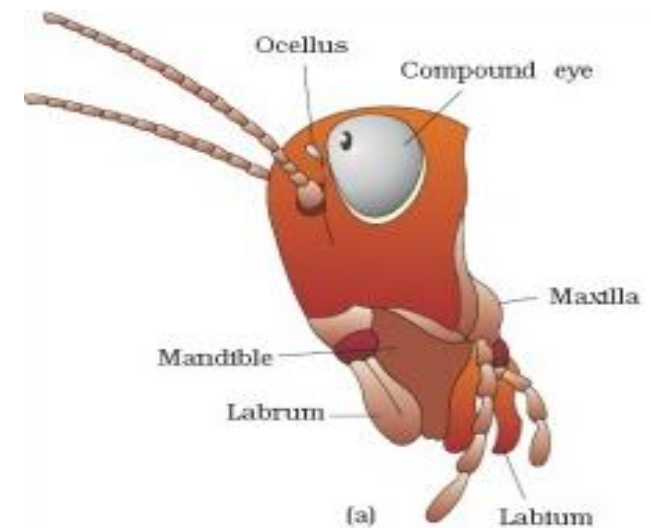
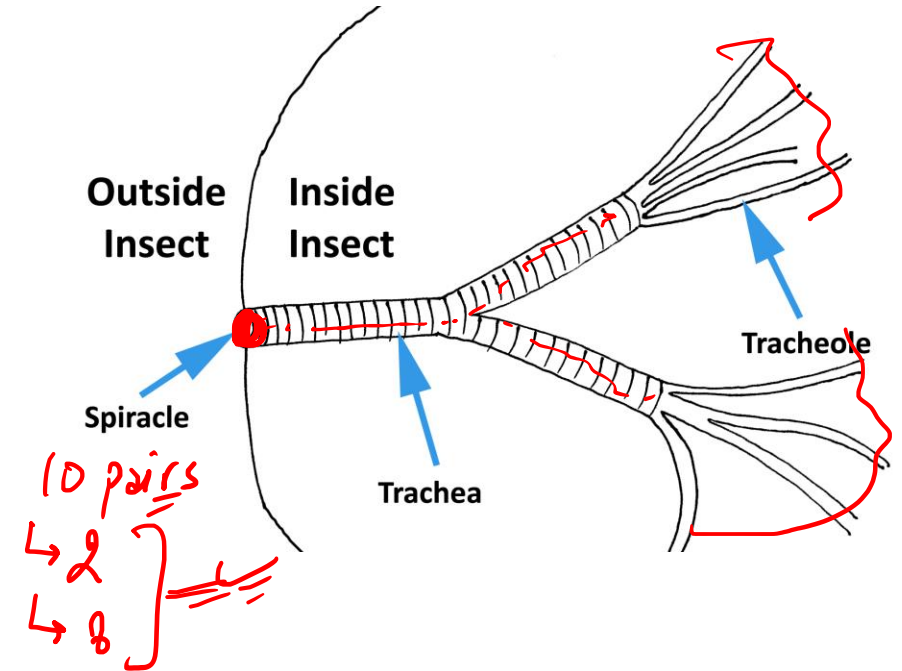
- Respiratory system consists of network of trachea which open through 10 pairs of **spiracles** on lateral side.

- The nervous system of cockroach consists of a series of fused, segmentally arranged ganglia joined by paired longitudinal connectives on the ventral side. Three ganglia lie in the thorax, and six in the abdomen. The nervous system of cockroach is spread throughout the body.



- Each compound eye of cockroach consists of about 2000 hexagonal ommatidia.

With the help of several ommatidia, a cockroach can receive several images of an object. This kind of vision is known as **mosaic vision** with more sensitivity but less resolution.



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-Cockroaches are dioecious.

Male reproductive system consists of a pair of testes one lying on each lateral side in 4th-6th abdominal segments.

Female reproductive system consists of two large ovaries situated on 2nd -6th abdominal segments.

- The fertilized eggs are encased in capsule called ootheca. 9 to 10 oothecae are produced by each female.

- Cockroaches are pests and destroys the food, contaminate with smelly excreta.

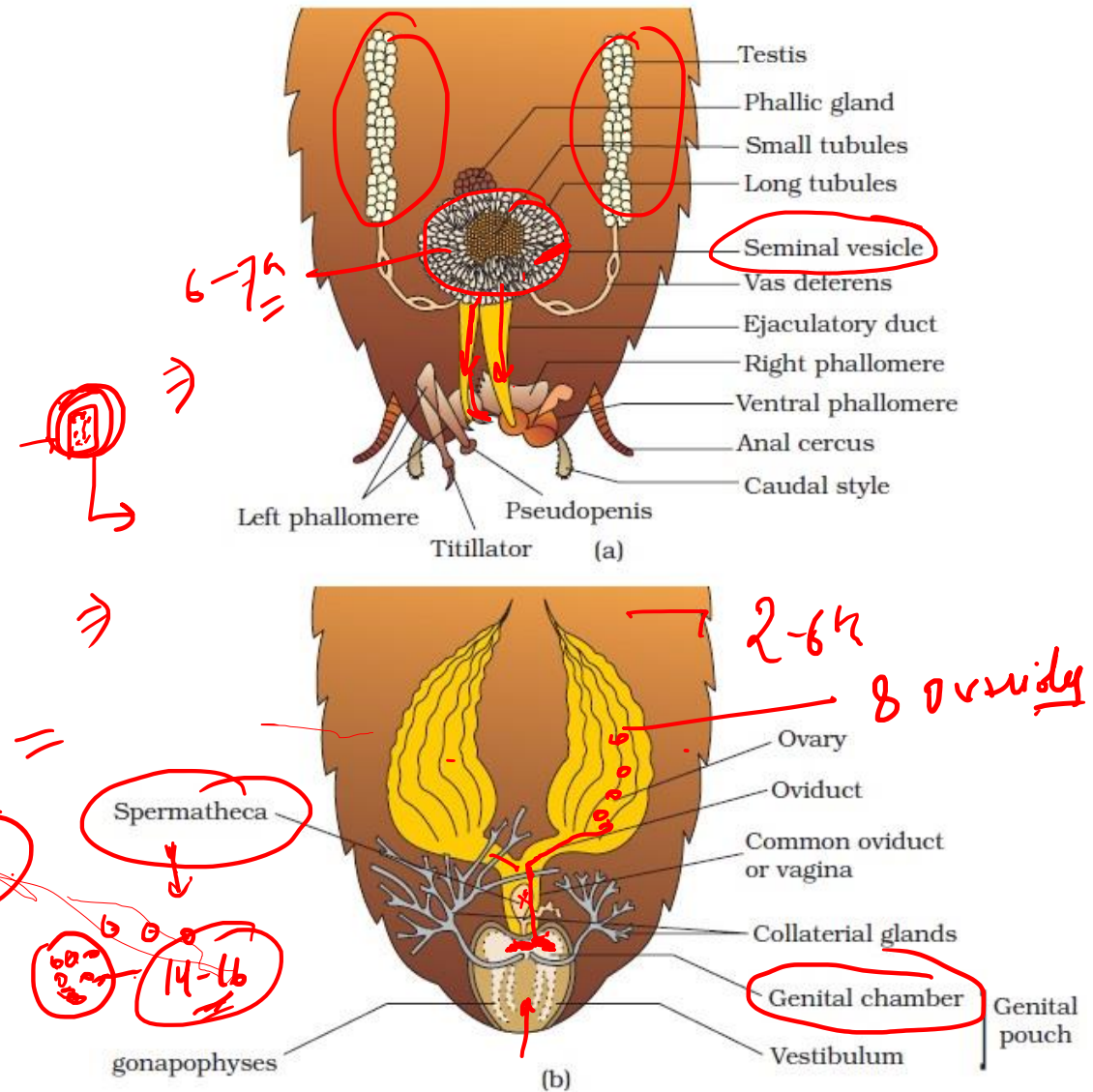


Figure 7.18 Reproductive system of cockroach : (a) male (b) female

Thank You